NPAFC
Doc. 330
Rev.

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by

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Submitted to the
NORTH PACIFIC ANADROMOUS FISH COMMISSION
by
JAPAN
October 1998

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:
T. Azumaya, Ishida, Y., and Y. Ueno. 1998. The long-term mean spatial and temporal distribution of CPUE for pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) in the North Pacific Ocean. (NPAFC Doc.330). National Research Institute of Far Seas Fisheries, Japan. 8p.

The Long-Term Mean Spatial and Temporal Distribution of CPUE for Pink Salmon (*Oncorhynchus gorbuscha*) and Chum Salmon (*O. keta*) in the North Pacific Ocean

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ABSTRACT

The long-term mean spatial and temporal distribution of pink salmon *Oncorhynchus gorbuscha* and chum salmon *O. keta* in offshore waters of the North Pacific Ocean was investigated using the data collected on board Japanese salmon research vessels from 1972 to 1992. Pink salmon were distributed in a wide zonal band between 40°N and 50°N and the area of higher CPUE shifted westward as the season progressed. On the other hand, the CPUE of chum salmon was one order of magnitude lower than that of pink salmon. In spring, chum salmon were more widely distributed than pink salmon, with mature chum salmon distributed near coastal waters and the proportion of immature fish increasing in offshore waters as the season progressed.

The distribution of chum salmon differed between odd and even years inversely to the pattern observed for pink salmon. In the Bering Sea, the CPUE of pink salmon was higher in odd years than in even years, and the CPUE of chum salmon was lower in odd years than in even years. Also the chum salmon distribution shifted southeastward in odd years. These results suggest that the interaction between pink and chum salmon changed their distributions in the offshore waters of the North Pacific Ocean.

INTRODUCTION

Pink salmon *Oncorhynchus gorbuscha* are the most abundant salmon species, followed by chum salmon *O. keta* in the North Pacific Ocean. One of the questions addressed in the NPAFC science plan is the interspecific interactions between these species, especially in spatial distribution (NPAFC, 1996). The variation in abundance for these species is clear from data on run sizes. However, little is known about the relationship between pink and chum salmon distributions in the ocean. In this report, we examine the monthly long-term mean distribution of these

two species using the data collected in offshore waters of the North Pacific Ocean from 1972 to 1992.

DATA AND METHODS

The data used were collected on board Japanese salmon research vessels in offshore waters of the North Pacific Ocean from 1972 to 1992. The number of operations during the 21 year period from 1972 to 1992 in the North Pacific Ocean totaled 108,756 (Fig.1). However, the number of operations in the eastern North Pacific Ocean was smaller than that in the western North Pacific Ocean.

Salmon research vessels have used research-type gillnets(containing 10 different mesh sizes ranging from 48 to 157 mm). We analyzed the data obtained by research-type gillnets because this gear is non-selective. To describe the distribution of pink and chum salmon, data from the area between 30°N-65°N, 130°E-130° were stratified by month, by 2 degree latitude by 5 degree longitude areas (2°×5° grid), and by species. Fig.2 shows the total number of operations in each grid by month during 21 years. Although operations for 21 years were distributed over almost the entire North Pacific Ocean from May to August, they were restricted in local area of the North Pacific Ocean in other seasons.

To describe monthly changes in distribution of pink and chum salmon, the long-term mean CPUEs of these species over the 2°×5° grid were calculated for each month. The number of fish caught and the number of tans used were summed monthly and the catch-per-effort(CPUE) in each grid was calculated as followed :

CPUE = total catch in number/ total effort in 30 tans.

Similarly, the proportion of maturing and immature fish in each grid square were calculated based on Takagi's (1961) maturity definition, which is based on relative gonad weight.

RESULTS AND DISCUSSION

Fig. 3 shows the horizontal distribution of pink salmon from April to October. Pink salmon were distributed in a wide zonal band along the 42°N line from 142°E to 165°W in April and May, and were most abundant around 155°E. But, they were not distributed in the area north of 50°N. In June and July, pink salmon more widely distributed in the area south of 62°N in the Bering Sea. The CPUEs of pink salmon between 150°E and 165°E and between 42°N and 55°N exceeded 100. The area with relatively high CPUE shifted westward from April to July. In August and September, pink salmon were distributed only the coastal area, and they

were not caught in offshore waters in October. The monthly changes of distribution of CPUE for pink salmon appear to indicate their return migration to spawning area.

Fig. 4 shows the ocean distribution of chum salmon from April to October. The CPUE of chum salmon was one order of magnitude lower than that of pink salmon. In April and May, chum salmon were widely distributed in the area east of 145°E and north of 40°N in the western North Pacific. But the center of distribution for maturing fish was farther north than that of immature fish. From June to July, the distribution of maturing chum salmon shifted progressively northwestward to the coast of Kamchatka, and northeastward to the Alaskan coast. Immature chum salmon were widely distributed from 40°N to 60°N and were most abundant in the Bering Sea. In August and September, maturing fish were rarely caught in offshore waters. In October, when fishing operations were limited to near the coastal waters, the proportion of maturing fish was high. The proportion of immature fish in offshore waters increased as the season progressed. These results suggest that immature chum migrated from south to north in offshore waters.

Fig. 5(a) and (b) show the distribution of CPUE for pink salmon in odd and even years in July, respectively. Pink salmon were more widely distributed in odd years than in even years. Moreover, the CPUE of pink salmon was also higher in odd years than in even years except in the Gulf of Alaska. Particularly in the Bering Sea, odd year CPUEs exceeded 50, while they were less than 10 in even years. Thus, a difference in both the distribution and CPUE of pink salmon between odd and even years is evident in offshore waters of the North Pacific Ocean.

Fig. 6(a),(b) shows the July CPUE distribution of chum salmon in odd and even years, respectively. In the western North Pacific, the difference of CPUE between odd and even years was not clear. On the other hand, the CPUE was lower in odd years and higher in even years in the Bering Sea. Especially, the difference of CPUE of immature between odd years and even years was clear. In the eastern North Pacific, the CPUE was higher in odd years and lower in even years.

Fig. 7(a), (b) shows the odd year July CPUE anomaly from the mean for pink and chum salmon, respectively. Negative CPUE anomalies are highlighted by hatching. For pink salmon, the highest CPUEs (positive anomalies) were found in areas north of 45°N in the western North Pacific and in the Bering Sea (Fig.7(a)). These areas correspond to the regions of lower than average CPUE (negative anomalies) for chum salmon (Fig.7 (b)). The positive areas of chum salmon were also found between 180° to 170°W at 46°N and in the Gulf of Alaska. These results suggested that chum distributions were affected by pink salmon and shifted from the Bering Sea to the eastern North Pacific.

ACKNOWLEDGEMENTS

We would like to thank Dr. K. Nagasawa and Dr. D. Welch for his critical comments on this report. Mr. A. Nitta is thanked for data analysis.

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Takagi, K. 1961. The seasonal change of gonad weight of sockeye and chum salmon in the North Pacific Ocean, especially with reference to mature and immature fish. Bull. Hokkaido Reg. Fish. Res. Lab. 23:17-34.

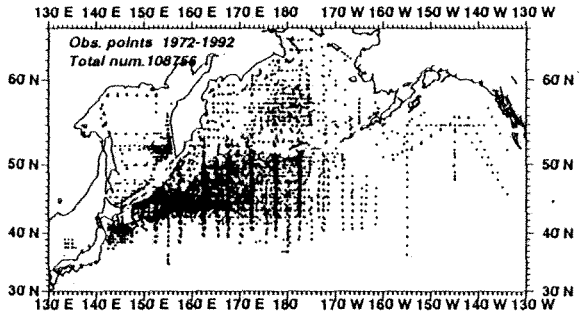


Fig. 1 The distribution of operations (1972 to 1992) used in calculating areal averages for this report.

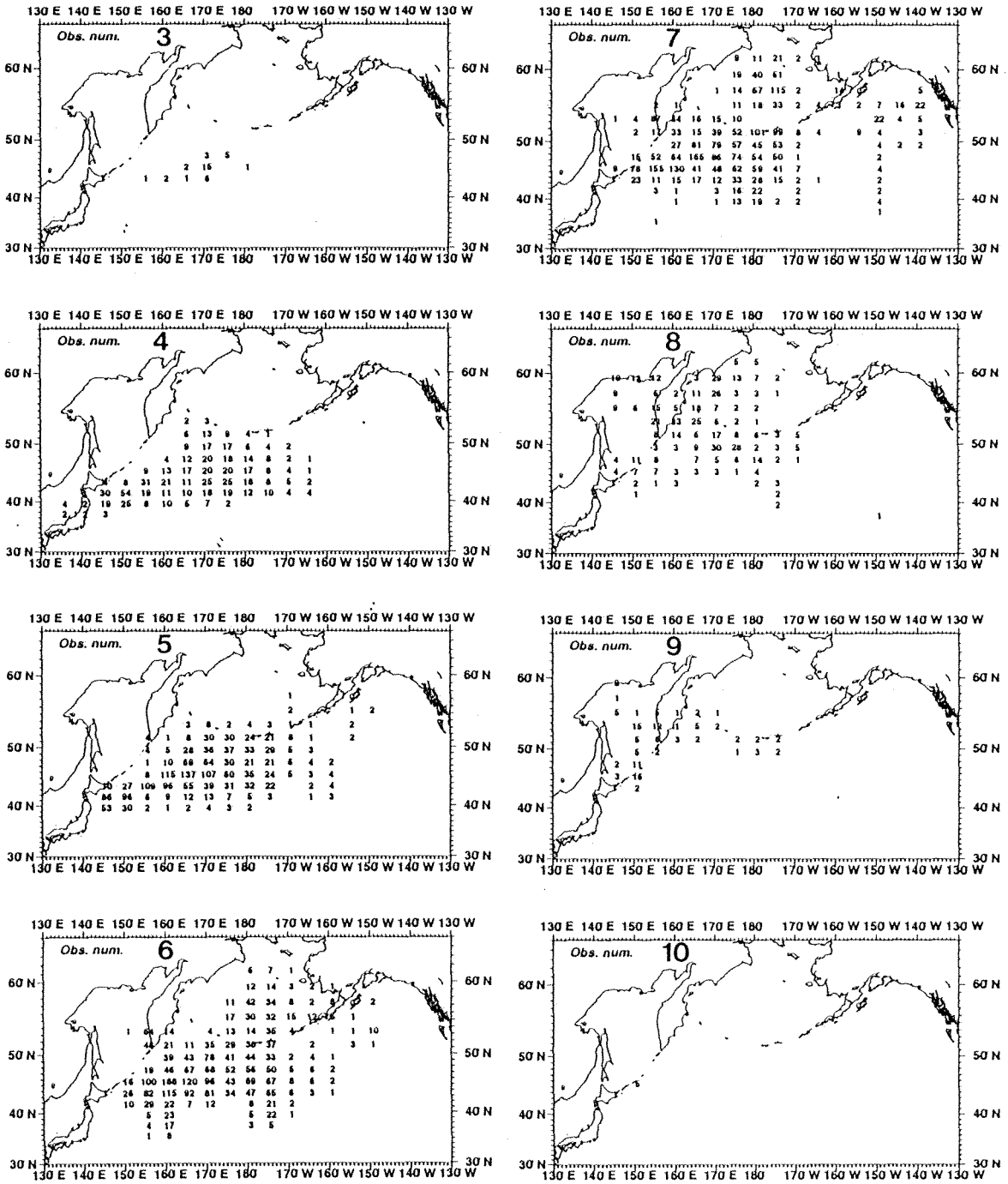


Fig. 2 Map of the numbers of monthly summed operations in each 2°×5° (lat.×long.) rectangle.

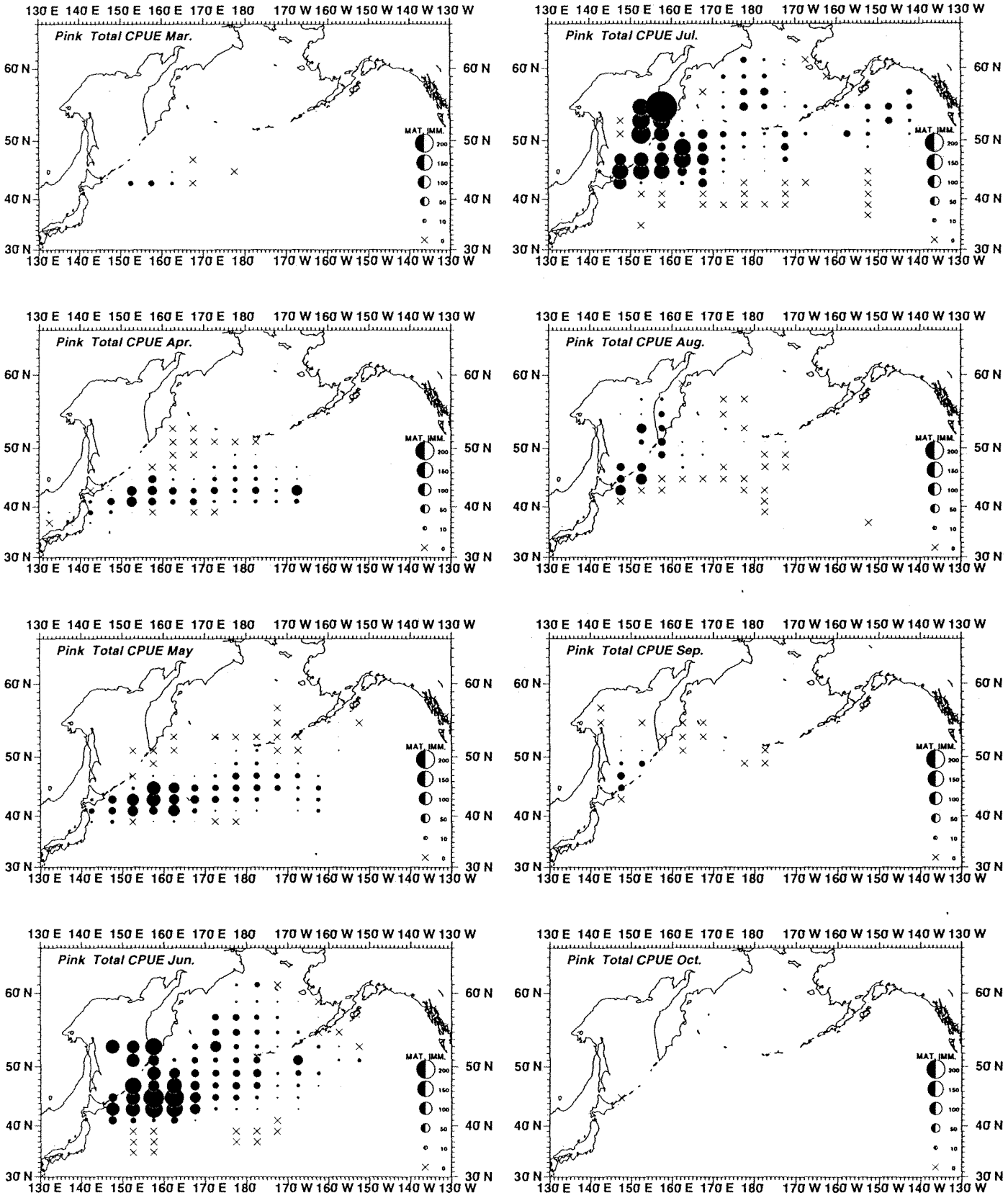


Fig. 3 Monthly long-term mean distribution of CPUE of pink salmon in the North Pacific Ocean.

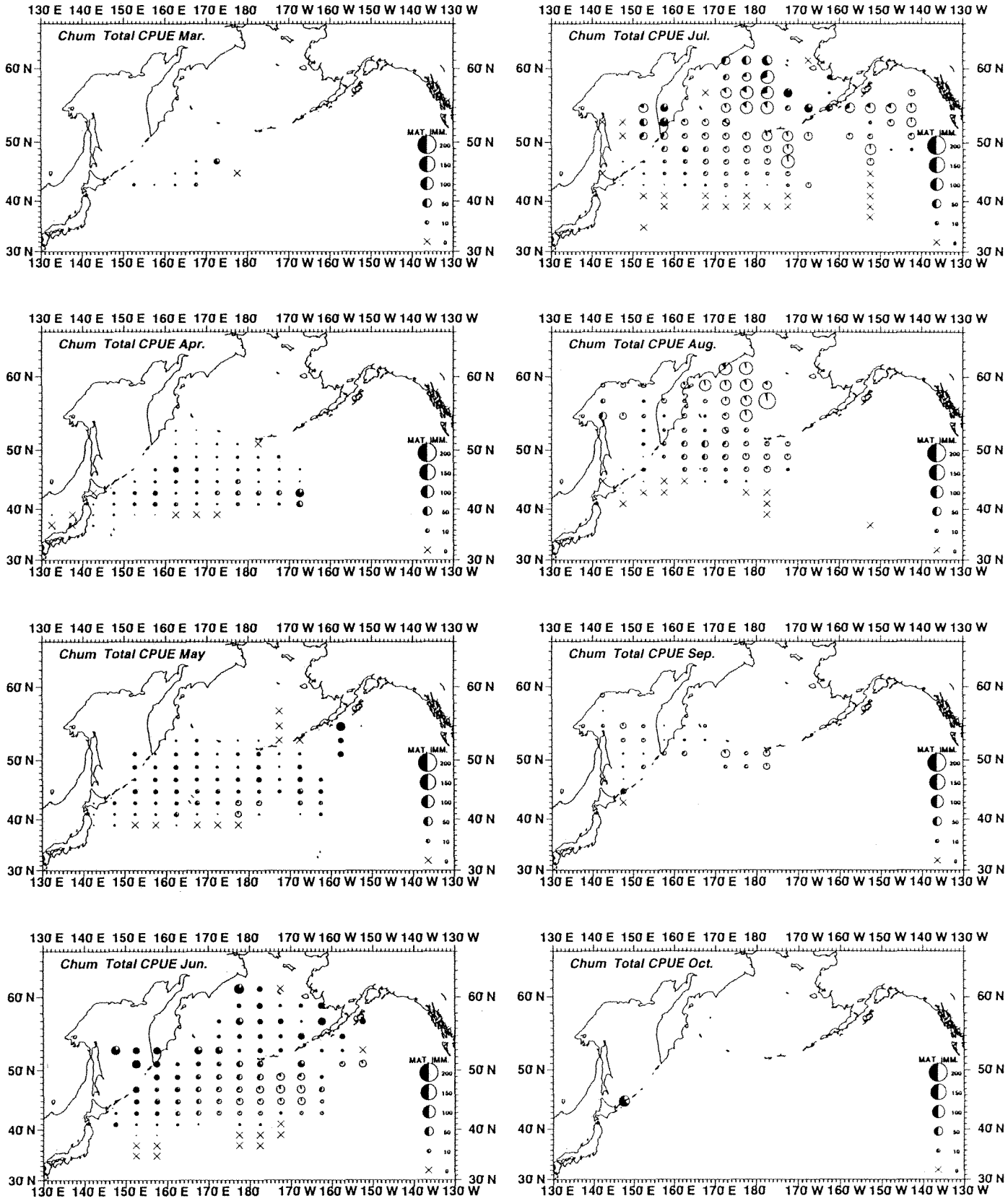
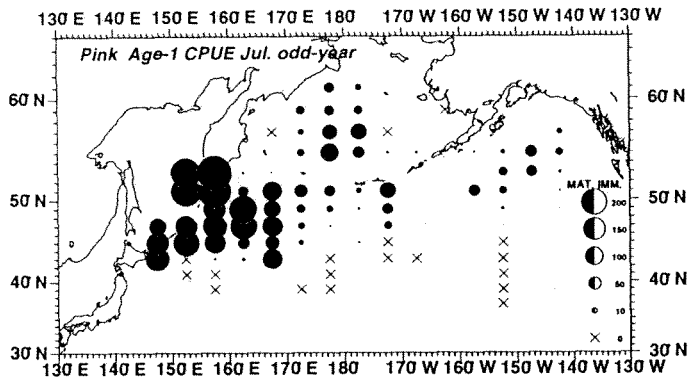


Fig. 4 Monthly long -term mean distribution of CPUE of chum salmon in the North Pacific Ocean.



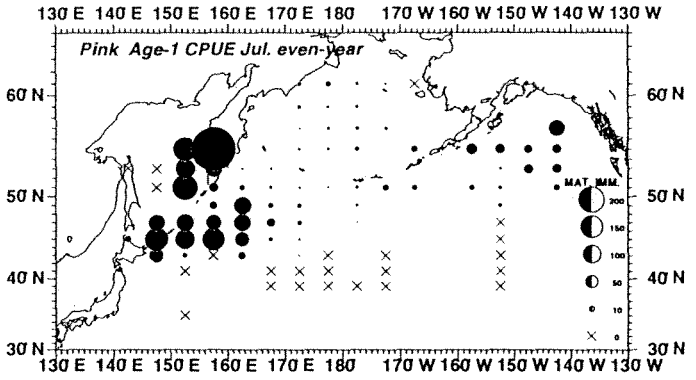
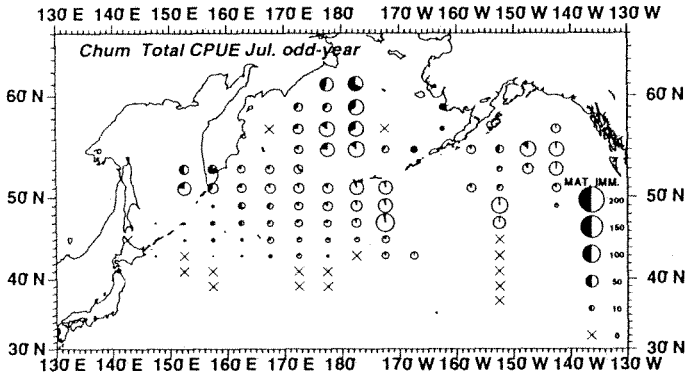


Fig. 5 The distribution of pink salmon in odd (a) and even (b) years in July.



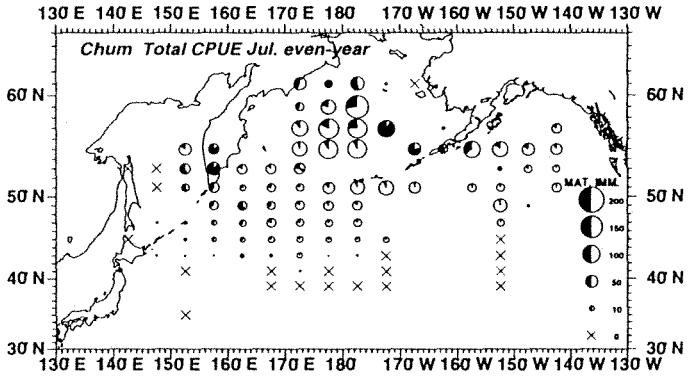
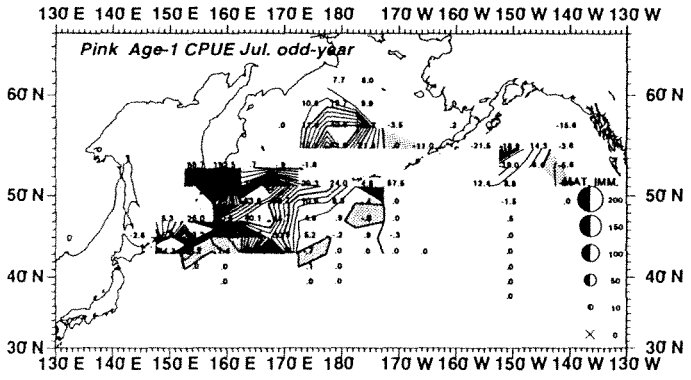


Fig. 6 The distribution of chum salmon in odd (a) and even (b) years in July.



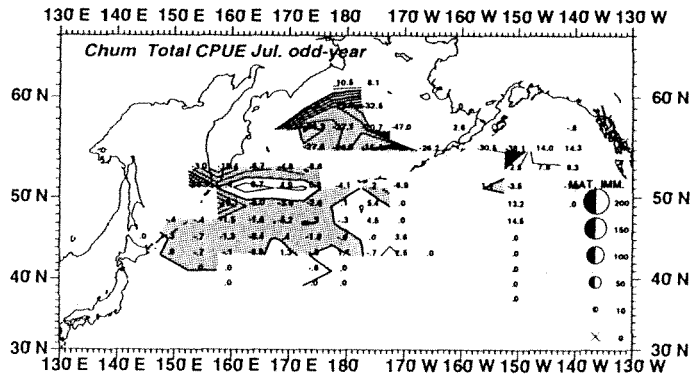


Fig. 7 Map of anomalies from long-term mean July CPUE for odd years. (a) Pink salmon, (b) Chum salmon.